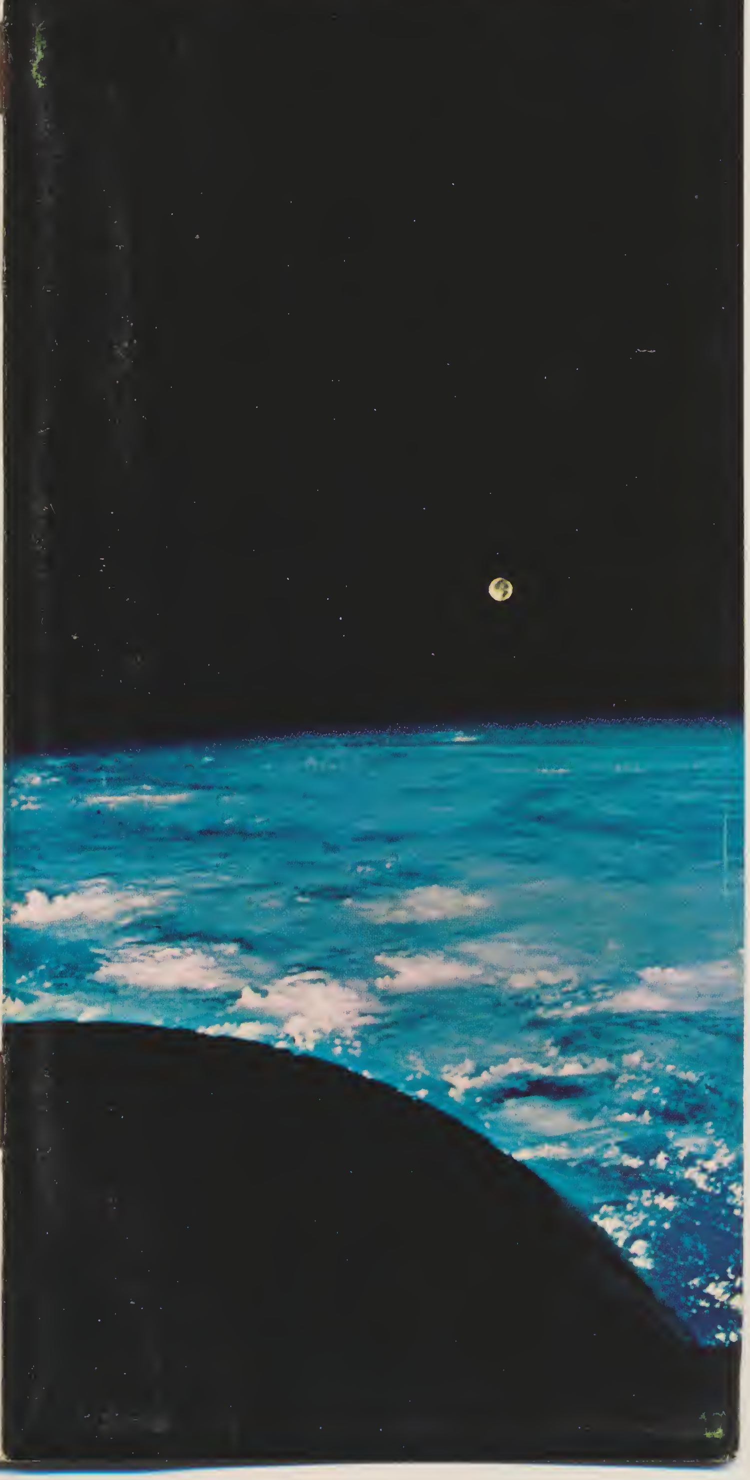
MCDONNELL AIRCRAFT CORPORATION
BOX 516, ST. LOUIS, MISSOURI 63166

AD-001-0466

MCDONNELL

Prologue to the Future



Cover photograph taken from Gemini VII spacecraft during its two week mission in December 1965.

MCDONNELL

Prologue to the Future

SAINT LOUIS, MISSOURI

"We are 120 feet apart and steady."

World's first space rendezvous, 1:27 pm CST, 15 December 1965, 185 miles above the Pacific Ocean.

Original offices of McDonnell Aircraft Corporation were on the second floor of this building.

On 6 July 1939, 40-year-old James Smith McDonnell, Jr., a slight, dynamic Scotsman from Arkansas founded the McDonnell Aircraft Corporation. The new business opened in a rented second floor office in a small building adjacent to the Lambert-St. Louis Municipal Airport, with two employees, including Mr. McDonnell himself, a typewriter, and no contracts.

Today, McDonnell Aircraft Corporation is an industrial complex flanking the same airport but with facilities valued at more than $125,-000,000, over 38,000 employees, and a record of product achievement that stretches from the first carrier based jet fighter to the world's first manned orbital rendezvous.

Three months after incorporation, engineering employment stood at 15. The first manufacturing order was for $7,672 worth of small parts for Stinson observation planes. In September 1940, the company received a $20,000 Army Air Force contract for jet propulsion research. And in December of that year, McDonnell was awarded its first major sub-contract for the manufacture of airplane parts.

A 180° photograph of the main office building and ramp.

XP-67 BOMBER DESTROYER

In September 1941, McDonnell won an Army Air Force contract for the XP-67 Bomber Destroyer, the first experimental airplane of all-McDonnell design, conceived to attain a maximum speed of 405 miles per hour, with a combat range of 2,385 statute miles. Although only one experimental airplane was flight-tested, this difficult pioneering project proved a worthwhile engineering exercise for the nascent creative team.

In January 1942, the Army Air Force awarded McDonnell a contract to produce twin-engine bomber trainers. This was the first production airplane contract awarded to the Company.

During World War II McDonnell manufactured 7,000,000 pounds of airframe components and employment reached 5,212.

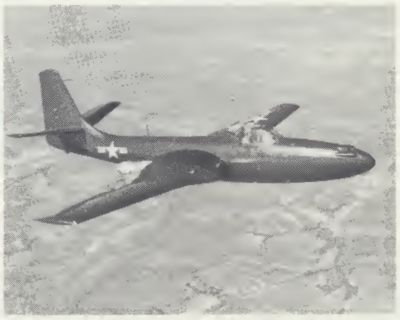
FH-1 PHANTOM

During the early years of the war, McDonnell research was concentrated on an application of the jet engine, at that time a new concept in propulsion. This advanced study was rewarded when, in January 1943, the Navy awarded McDonnell a contract to develop a jet-propelled, carrier-based fighter. This design was successful and two years later the company received a production contract for the FH-1 Phantom, a single seat, twin-jet fighter, which became the first Navy airplane to attain a speed of 500 miles per hour and the first of a historical series of McDonnell twin-jet fighter aircraft to go into production.

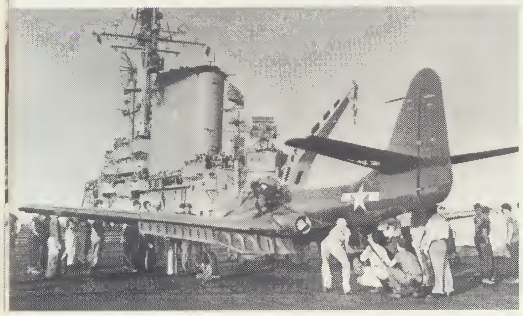
The Phantom proved its operational ability on 21 July 1946, when a test pilot performed a series of normal take-offs and landings on board the USS Franklin D. Roosevelt. This was the first combat jet aircraft to operate from the flight deck of a U. S. carrier.

The Phantom not only introduced a new era in Naval Aviation, it marked a turning point for McDonnell, for it put the company on a firm financial foundation in the difficult post-war period. Sixty aircraft were delivered to the fleet, the last one a full month ahead of schedule.

XP-67



FH-1 Phantom



FH-1 Phantom

F2H BANSHEE

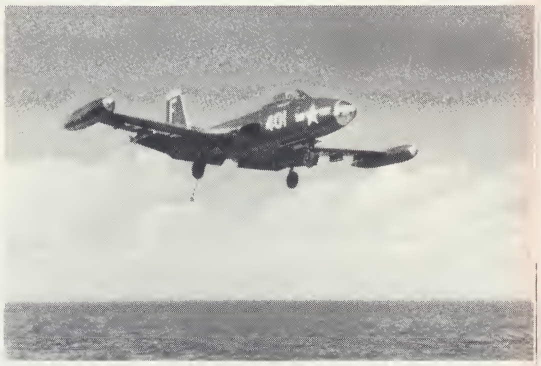
No sooner does production start on one aircraft than design starts on a newer version or a totally new concept. Thus it was not unusual that in the month McDonnell received a production contract for the Phantom, engineers began the experimental design of a more powerful twin-jet Navy fighter, the XF2H-1 Banshee.

The Banshee was ordered into production in May 1947. By mid-1948, this aircraft was being developed in day fighter, night fighter, and photo-reconnaissance versions. The first production Banshee was delivered to the fleet in 1949. On 31 October 1953, the last of 895 Banshees, of all types, was delivered on schedule.

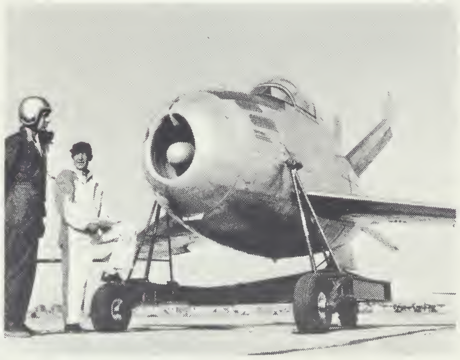
During the Korean War, the Banshee played a major fighting role as a fighter-bomber and photo-reconnaissance aircraft with the Navy and Marines. Equipped with 20 millimeter cannon, plus bombs and rockets, the fighter version made hundreds of tactical raids on enemy supply lines. The photo version utilized color and camouflage detection film for reconnaissance missions over enemy positions.

XF-85 GOBLIN

One of the smallest jet aircraft ever built, the McDonnell XF-85 Goblin began experimental flights in 1948. The Goblin had no landing gear, and was developed for the Air Force to operate from the bomb bay of the giant B-36 Bomber. This compact fighter incorporated all the equipment of a high altitude interceptor and was powered by a 3,000 pound thrust jet engine. Before development could be completed, however, the success of smaller, faster jet bombers signalled the end of the B-36 era and the XF-85 concept was discontinued.



F2H Banshee



XF-85 Goblin

F2H Banshee

MULTIPLE MISSION ENGINEERING

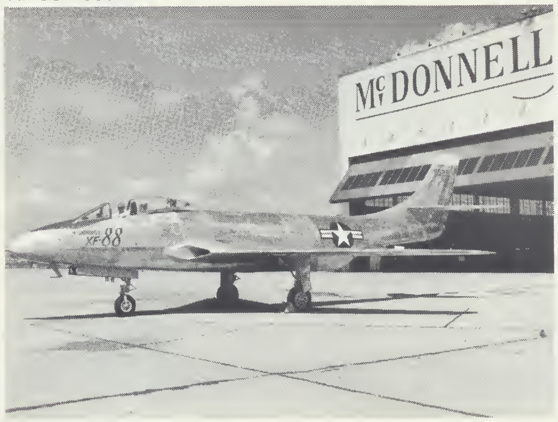
Early in the history of the Company, McDonnell engineers took into consideration the combat requirements of not just one service but all services. They designed not for just one mission but for many missions. The significance of this multiple-service engineering effort became more apparent with each passing year.

At almost the same time McDonnell engineers began the development of the Banshee, another group started advanced design of the XF-88, a long range, supersonic penetration fighter for the Air Force, which was first flown in 1948.

F-101 VOODOO

As development continued, the design evolved into the F-101 Voodoo, eventually to be used

XF-88 Voodoo



F-101B, F-101C, and RF-101 Voodoos

by three major U. S. Air Force Commands, Strategic, Tactical, and Air Defense. Three versions—long-range attack fighter, interceptor, and photo-reconnaissance—accounted for a total production of 807 Voodoos.

The Voodoo became operational in 1957 and proceeded to set numerous world speed records, including three transcontinental records and a world's straight-away speed mark of 1,207 miles per hour.

The Voodoo is deployed with the USAF all over the world. Sixty-six F-101B interceptors were transferred to the Royal Canadian Air Force in 1961. USAF RF-101 Reconnaissance Voodoos made repeated low-level forays over missile sites to bring back evidence of the Soviet missile build-up in the 1962 Cuba crisis.

RF-101 Voodoo

HELICOPTER DEVELOPMENT

Through the years, McDonnell helicopter research has contributed a number of advancements in rotor systems, rotor dynamics, dynamic wind tunnel testing of rotor systems, and rotor propulsion.

The McDonnell XHJD-1 (Navy) was the world's first twin-engine helicopter. This 5½-ton vehicle, with reciprocating engines powering shaft-driven rotors, became a flying helicopter laboratory.

The world's first ramjet helicopter was the McDonnell XH-20 (Air Force). A pioneering helicopter development, this flying test-stand had a McDonnell ramjet in each rotor tip. The tip-driven rotor eliminated the need for a torque-compensating tail rotor.

The XV-1 (Army) compound helicopter made the first successful conversion from vertical rotor lift to horizontal winged flight. This research vehicle combined hovering capability with a speed of 200 mph. The rotor was powered by McDonnell-designed and built blade-tip-mounted pressure jets.

Military evaluation showed exceptional hover and dynamic longitudinal stability for the Model 120, a "flying crane" of diminutive size but unusual lift capabilities. Powered with McDonnell roto-tip-mounted pressure-jets, this experimental craft could carry a useful load exceeding its own empty weight.

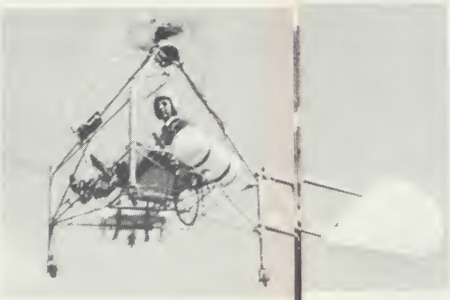
F3H DEMON

McDonnell's association with the Navy, which had its foundation in the flights of the Phantom I in 1946, has never been interrupted. As early as January 1949, long before the last Banshee left the flight ramp in St. Louis, development started on the F3H Demon, an all-weather, carrier-based fighter. The F3H-2N Demon combined interceptor radar with fighter speed and maneuverability. Powered by a single Allison J-71 engine, the Demon carried missiles, rockets, bombs, fuel tanks, or miscellaneous stores. It was the first aircraft designed for missile armament rather than guns.

The F3H made its first flight on 7 August 1951, and production deliveries began in 1953. Flying day and night, the Demon provided all-weather fleet defense during the critical operations in Lebanon and Quemoy in 1958.

The last of 519 Demons was delivered in November 1959, completing a ten-year program.

XV-1



XH-20 Little Henry

XHJD-1

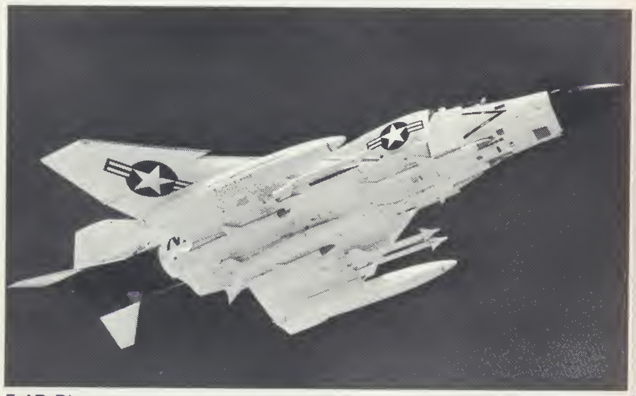
Model 120

F3H Demon

PHANTOM II

In the summer of 1953, preliminary design began on an aircraft that was to be selected for service by all three air arms of the United States. McDonnell's adherence to the concept of multi-mission, multi-service aircraft design reached maturity in the creation of the Phantom II, a radically new fighter qualified to perform every classical fighter mission ever conceived.

The Phantom II is a supersonic, two-place, twin-jet, all-weather fighter. In its early development, the Phantom II was designed as a long-range all-weather attack fighter, but fleet requirements changed its primary mission to that of a long-range high-altitude interceptor, using missiles as the principal armament. As an interceptor, it can carry six Sparrow III missiles, one under each wing and four semi-recessed in the fuselage, or four heat-seeking Sidewinders, two under each wing, and four Sparrow IIIs semi-submerged in the fuselage.



F-4B Phantom II

F-4B Phantom IIs

The Phantom was designed for carrier operations, but proved to be equally effective for land-based operations. Retaining much of its original attack-design structure along with the capability for low-speed flying, the Phantom II is qualified for long-range air-to-ground strikes from runways of under 5,000 feet. As an attack aircraft it is capable of carrying a multi-ton load of conventional bombs, rockets, missiles, guns, napalm, or nuclear strike weapons, in addition to its self protective Sparrow III armament.

The unrefueled range of the Phantom II operating from carriers or existing suitable friendly land bases allows the aircraft to carry its payload of ground strike weapons over 92% of the earth's surface. As an air superiority fighter, its combat range extends over 96% of the Earth's surface.

F-4C and F-4B Phantom IIs

RECORD FLIGHTS OF THE PHANTOM II

The Phantom II's outstanding performance was demonstrated even before it became operational. During pre-service development, the airplane established its place in aviation history by zoom-climbing to a record 98,557 feet. On 5 December 1961, it set a world's class record for horizontal flight at sustained altitude, maintaining 66,443.8 feet over a measured 25 kilometer course.

Another measure of the Phantom II's potential lay in its ability to maneuver at high speeds. On 5 September 1960 a Phantom II set a 500-kilometer closed-course record of 1216 mph and 20 days later it established a 100-kilometer world closed-course record of 1390 mph. While flying a circular path less than 20 miles in diameter, the airplane sustained a continuous centrifugal load of more than 3 g's throughout the Mach 2 turn.

In August 1961, a Phantom II flew four times through a low altitude 3 kilometer course (at times less than 50 feet above the ground) at an average speed of 902.77 mph to capture the world record for that distance and establish its low altitude attack and re-attack capability.

In May 1961 a Phantom II crossed the North American continent at the rate of a mile every four seconds to set a new transcontinental speed record for the 2421.42 statute miles from Los Angeles to New York.

The Phantom II's intercept capability was exhibited in setting the world's absolute speed record of 1606.3 mph. During this record flight on 22 November 1961, the Phantom II reached peak speeds in excess of 1650 mph (Mach 2.5+).

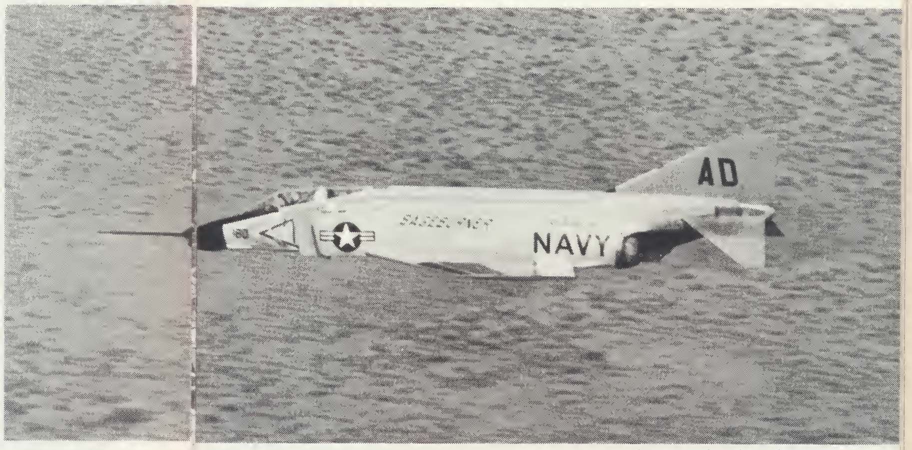
During the months of February-April 1962, the Phantom II set eight official world time-to-climb records:

Meters	Feet	Seconds
3,000	9,842	34.52
6,000	19,685	48.78
9,000	29,527	61.62
12,000	39,370	77.15
15,000	49,212	114.54
20,000	65,617	178.50
25,000	82,021	230.44
30,000	98,425	371.43

These records emphasized the Phantom II's capability for reaching any altitude from a standing start in record time. In establishing the 30,000 meter time-to-climb record, the airplane eclipsed its previous peak altitude mark by zooming to an altitude of over 100,000 feet.

The global range capability of the Phantom II was demonstrated in an 18-hour, 10,000 mile, non-stop flight of four Tactical Air Command Phantoms from MacDill AFB, Florida, on 1-2 December 1964.

High Altitude Flight



Low Altitude Flight

PHANTOM ACCEPTANCE

Designated the F-4B, the Phantom II is operational with both the Atlantic and Pacific fleets as an anti-air warfare interceptor and long-range attack aircraft. The F-4B Phantom II is also in service with the U.S. Marines for the conduct of close support, intercept, and air superiority missions. As the RF-4B, it is being built to meet Marine reconnaissance requirements.

Designated the F-4C and F-4D by the Air Force, the Phantom II is being produced to perform such missions as air superiority (day or night all-weather), long range attack, close air support, and interdiction for the Tactical Air Command. The RF-4C provides multiple sensor reconnaissance capability for the Air Force.

In 1964, the British Government contracted with our Government to procure the Phantom for both the Royal Navy and the Royal Air Force. On 30 September 1964, McDonnell was authorized to develop and produce two prototype and two production F-4K Phantoms for the Royal Navy, and on 5 May 1965 was authorized to produce two F-4M Phantoms for the Royal Air Force.

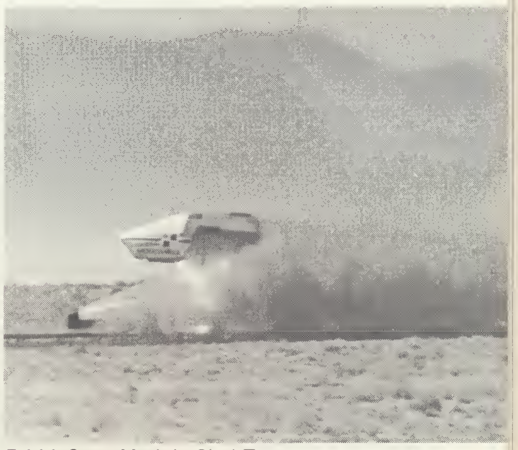
On 7 July 1965, only 4½ years after the first Phantom was delivered to a Navy squadron, McDonnell delivered the 999th F-4, an RF-4B to the Marines, the 1000th, an F-4B to

the Navy, and the 1001st, an F-4C to the Air Force.

Various versions of the Phantom are operating in Europe and Southeast Asia, and from aircraft carriers in the Atlantic, Pacific, and the Mediterranean. Reports from U. S. Navy, Marine Corps, and Air Force combat squadrons testify to the effectiveness of the Phantom as our nation's first-line interceptor, fighter-bomber, and escort aircraft.

F-111 CREW MODULES

In October 1963, McDonnell received a letter of intent from the Department of Defense for the development and production of crew modules for the F-111 aircraft being manufactured by General Dynamics, Fort Worth, Texas. In this unique, McDonnell-designed emergency escape system, the crew remains in an enclosed, pressurized cockpit which can be ejected at any aircraft speed or altitude. A flexible linear-shaped charge cuts the cockpit section from the fuselage and a 27,000 lb. rocket boosts it from the aircraft. A parachute then lowers the module, containing its own life support systems for crew survival, to a soft landing on land or water. During June 1964, McDonnell began delivery of interim modules for use in flight test aircraft, and in December 1965 began delivery of production modules.



F-111 Crew Module Sled Test

1000th Phantom II Delivery

MISSILE ENGINEERING

While jet aircraft dominated the products produced by McDonnell during most of its first two decades, advanced concepts in missile engineering early captured the Company's attention.

Contract-supported missile programs at McDonnell began in 1944 with a Navy contract for a radio-controlled dive bomb, the KUD-1 Gargoyle.

TALOS

In the late 1940s, in conjunction with the Applied Physics Laboratory of Johns Hopkins University, McDonnell evolved the configuration of Talos, a supersonic, surface-to-air missile for the U.S. Navy. In March 1951, the company received a subcontract from Bendix Corporation, the prime contractor, to produce airframes and integrated ramjet engines. The first missile was delivered in June 1952. In February 1959, Talos became operational on U.S. Navy guided missile cruisers.

This long association was concluded early in 1966, and in April 1966 McDonnell delivered its last airframe. Through the years McDonnell delivered a total of 1,916 airframes in nine different configurations.

GAM-72 QUAIL

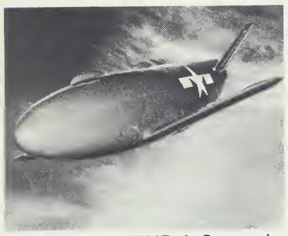
Out of McDonnell's missile engineering activity also came an unusual weapon with a mission as strange as its appearance, the jet powered GAM-72 Quail. Designed for launching from the bomb bay of a B-52 bomber, the Quail acts as a decoy to draw the firepower of the enemy away from target-bound B-52s. SAC Stratofortresses carry McDonnell GAM-72s in addition to their bombloads. By duplicating the flight characteristics and radar appearance of the parent aircraft, they confuse and saturate enemy defense systems. The Quail greatly increases the penetration capability of the bomber force, yet it costs less than 2% of the cost of the bomber it represents to the enemy. The final production missile was delivered to the Air Force on 28 May 1962.

MAW

In March 1966, the U. S. Army awarded McDonnell a development contract for a shoulder fired, antitank assault weapon system for use as a defensive weapon system against tanks and armored vehicles and as an assault weapon against infantry combat targets. It can be carried, set up, and fired by one infantryman on any terrain. The gunner simply keeps the cross hairs of a telescopic sight on the target and launches the missile, which is automatically guided throughout its flight.

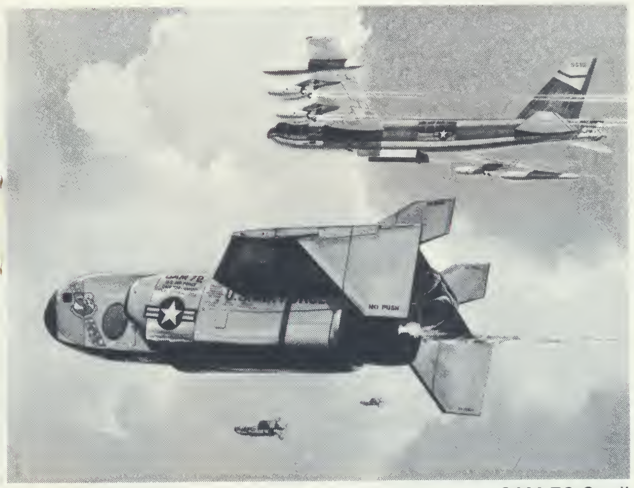
HYPERSONIC FLIGHT

Early company investigations in hypersonic aerodynamics were related to contractual development of hypersonic bomber defense missiles



KUD-1 Gargoyle

Talos



GAM-72 Quail

for the Air Force. In 1954 this experience was applied to a program for the study of hypersonic flight within the atmosphere. Three test missiles based on the concept of aeroballistic or lifting body flight were launched from Cape Kennedy early in 1959.

Level flight was achieved at over Mach 5 within the atmosphere. McDonnell's design proved to be a breakthrough in the development of aerospace vehicles capable of atmospheric maneuvering flight at hypersonic speeds.

ASSET

McDonnell continued the study of atmospheric flight and aerodynamic heating at hypersonic speeds in a program callet ASSET. Developed and built under the sponsorship of the Air Force Flight Dynamic Laboratory, ASSET was an unmanned, winged, flying test materials laboratory designed to expand the technology of lifting body reentry.

McDonnell produced six test vehicles with the same external shape but different internal equipment requirements. These consisted of four vehicles designed to measure the aerodynamic and heating environment and two to measure the aerodynamic vibration and oscillatory environment. All six were designed to be flown through a portion of the gliding reentry regime to measure temperature and pressures and to evaluate the refractory metals structure.

Utilizing materials capable of maintaining structural integrity at operating temperatures ranging between 2000° and 4000° F., ASSET was constructed of such metals as molybdenum,

ASSET

Aeroballistic Missile

columbium, cobalt alloy, graphite, zirconia-oxide, and titanium, and McDonnell had to devise new techniques to fabricate them.

The flight test program consisted of six flights launched from Cape Kennedy by Thor and Thor-Delta rockets. The result of more than two years of intensive effort, the flight of ASSET 1 on 18 September 1963 represented the Free World's first hypersonic maneuverable boost glide flight through the atmosphere. The sixth and last flight on 23 February 1965 was the hottest, fastest, and most severe test in the entire program.

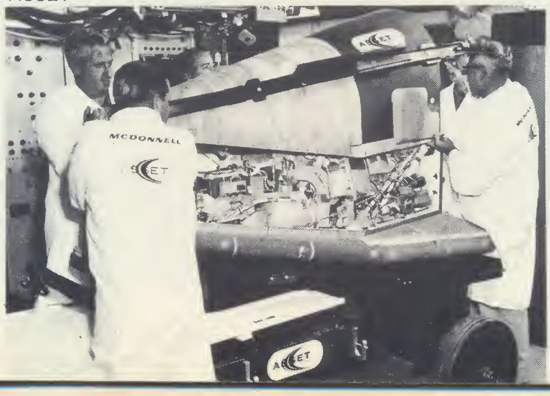
ASSET spacecraft were launched to altitudes up to 202,000 feet from which they flew at speeds up to Mach 18.8 (approximately 19,500 fps). Each vehicle was equipped with 130 or more measuring devices which telemetered back technical data on ASSET's performance in the hypersonic glide environment.

A major step toward attaining precision control during reentry, ASSET was the first successful reusable non-ablative flightworthy airframe. ASSET was also the first to demonstrate operationally the penetration ion sheath which causes communications blackout by use of X-band telemetry.

BGRV

On 15 October 1964, McDonnell received a contract with the Air Force Ballistic Systems Division for work on a feasibility test program for a boost glide reentry vehicle. The vehicle is boosted into the upper atmosphere and then glides at hypersonic speeds toward its target.

ASSET



MERCURY MANNED ORBITAL SPACECRAFT

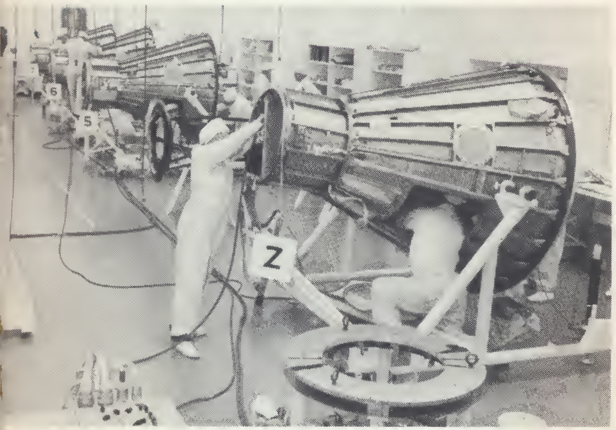
On 12 January 1959, NASA selected McDonnell as prime contractor for Mercury, the Free World's first manned orbital spacecraft.

Manifold problems were involved because there were no prototypes. No vehicle had ever been built that would enable a human being not only to live but to function effectively during launch, orbit, and reentry. No engineering data had been accumulated on the reentry problems anticipated with a craft the size of Mercury.

There were physical space limitations and weight limitations because of the power of available launch vehicles. The safety of the astronaut was paramount, and from contract signing to launch day, improvements had to be made to insure his safety.

Because of the unknown environment into which the astronaut would be placed, all systems had to be automatic. And because a study of man's capabilities in space was basic to the mission, provisions had to be made for manual control. A third system of control was linked to a network of stations on the ground by radio.

Time limitations were also introduced, because McDonnell's development and production phases had to coincide with NASA's research and test phases.



Mercury Manufacture

FIRST FREE MAN IN SPACE

For sheer thrill of accomplishment for an industrial team, there probably never has been anything to compare with that engendered by the first manned flight into space of the Project Mercury Spacecraft on 5 May 1961. That day, Astronaut Alan B. Shepard rode into history with his ballistic flight beyond the atmosphere in *Freedom 7.* His calm engineering appraisal of his mission, and his precision demonstration of man's ability to perform useful control functions in a space environment were watched by the world. Eleven weeks later, Astronaut Virgil I. "Gus" Grissom duplicated the feat in *Liberty Bell 7.*

THE FLIGHT OF JOHN GLENN

Three years and 39 days after the Mercury contract was awarded, *Friendship 7,* with Astronaut John Glenn aboard, was launched from Cape Kennedy by an Atlas launch vehicle.

After three orbits of the earth, the *Friendship 7* Spacecraft and its astronaut returned safely and were recovered. The initial assignment of Project Mercury was completed with this flight. The spacecraft was proved. Man's ability to adapt to the space environment had been demonstrated. His safe recovery had been achieved.

The flights which followed added to man's knowledge of space. Astronaut Scott Carpenter,

John Glenn and Friendship 7

Mercury Landing

in *Aurora 7,* investigated man's visual perception, photographed the launch vehicle and the sun from his atmosphere-free vantage point, and drifted for long periods in free flight. Walter M. Schirra, Jr., in *Sigma 7,* which he later referred to as "A Jewel", extended Mercury's range to six orbits in a near perfect flight.

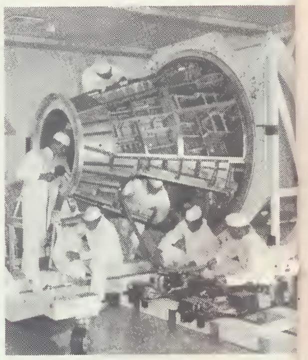
The Mercury Project was successfully concluded with the dramatic 22 orbit flight of Astronaut L. Gordon Cooper in his *Faith 7* Spacecraft, 15-16 May 1963. Cooper piloted *Faith 7* through a manual reentry and landed less than five miles from the prime recovery carrier.

GEMINI ORBITAL RENDEZVOUS SPACECRAFT

On 7 December 1961, long before the Mercury program was completed, NASA released plans for a Gemini two-man spacecraft, similar in design but 50% larger in volume, also to be produced by McDonnell. NASA announced on 2 April 1963 that McDonnell would build 13 flight-rated Gemini spacecraft, plus boiler plate vehicles, mission and docking trainers for astronaut and ground crew training, and static test articles.

The first unmanned orbital test evaluation flight took place on 8 April 1964. The spacecraft and its attached second stage orbited successfully, and subsequently burned on reentry after orbital decay on 12 April. An unmanned, suborbital ballistic flight to test the effect of maximum reentry heat and stress conditions on the

Gemini



Gemini Manufacture

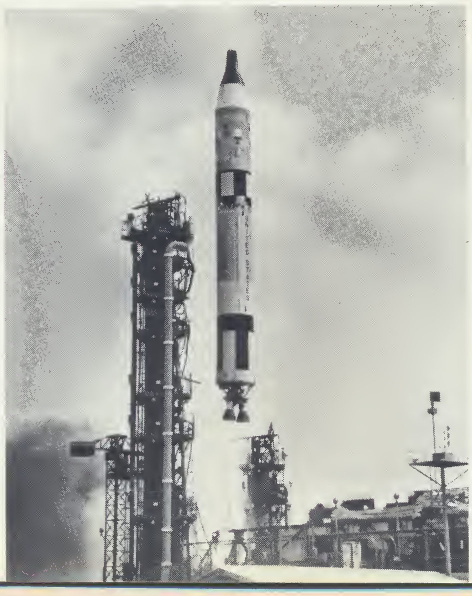
spacecraft and its systems was made on 19 January 1965. This spacecraft was recovered and returned to McDonnell to be refurbished and delivered to the Air Force for a preliminary unmanned flight in the USAF manned orbiting laboratory program.

GEMINI MANNED SPACE FLIGHTS

The first manned Gemini flight, with Virgil I. Grissom, Command Pilot, and John W. Young, Pilot, was launched on 23 March 1965. This 3-orbit mission which demonstrated the operation of all major systems and the maneuverability of the spacecraft, was the first space flight in history during which astronauts changed both their orbital plane and size of orbit.

Gemini IV, the first mission controlled from the Manned Spacecraft Center, Houston, Texas, made a 4-day, 62-revolution flight piloted by James A. McDivitt and Edward H. White II on 3-7 June 1965. During this mission, White became the first astronaut ever to maneuver himself in space through the use of a hand-held maneuvering unit. Two months later, on 21-29 August 1965, Gemini V, with L. Gordon Cooper, Jr. and Charles P. Conrad, Jr., made an 8-day, 120-revolution mission, which marked the first space flight application of fuel cell-produced electrical power.

Flown by Frank Borman and James A. Lovell, Gemini VII was a record-setting 206-



Gemini Launch

revolution, 13-day, 18-hour, 35-minute, 17-second mission beginning 4 December and ending 18 December 1965. During this mission Gemini VII also served as the rendezvous target vehicle for Gemini VI, manned by Walter M. Schirra, Jr. and Thomas P. Stafford, in the world's first spacecraft rendezvous on Wednesday, 15 December 1965.

The first twin launches ever conducted in the U. S. took place on 16 March 1966 when an Atlas-Agena was launched exactly on schedule and, a short time later, exactly on schedule, a Titan-Gemini was launched. Piloted by Neil A. Armstrong and David R. Scott, Gemini VIII rendezvoused with the Agena and performed the world's first successful docking of two orbiting spacecraft. The mission was terminated after seven revolutions because of a control thruster problem, but the crew demonstrated the value of a newly developed computer capacity by flying their spacecraft to a precision landing in the Pacific only three miles from the target point.

GEMINI B

In 1964, under contract with the Air Force Systems Division, McDonnell began to design the Gemini B spacecraft to be used in the Manned Orbiting Laboratory program. The Gemini B spacecraft is similar to the NASA Gemini configuration, except for a hatch cut through the ablation-type reentry heat shield. After the Gemini B, mated to the Manned Orbiting Laboratory, has been inserted into

orbit, the Astronauts move through this McDonnell-designed heat shield hatch into the laboratory. Upon completing their experiments, they return to the Gemini, separate from the MOL, and return to Earth.

Further Gemini flights are enabling NASA to perfect rendezvous and docking techniques preparatory to manned spacecraft probes deeper into space.

FACILITIES FOR A CREATIVE TEAM

In 1941, McDonnell began to purchase land and build for the future. During World War II, the Company operated facilities in Memphis, Tennessee, as well as at various locations in St. Louis. In August 1945, these wartime operations were consolidated in one plant. Under an agreement with the City of St. Louis, McDonnell occupied, on a leased basis, the former Curtiss-Wright facility at Lambert Field. On 31 July 1951, these buildings were purchased from the City. One of the contract conditions stipulated that all proceeds of the sale were to be paid into an Airport Improvement Fund. A unique terminal building, runway improvements, and other major developments at Lambert St. Louis Municipal Airport stem directly from this forward looking plan.

As the space age science of aeronautics and astronautics burgeoned, McDonnell continued to enlarge and improve its facilities. Since 1950, the Company has invested more than one hundred million dollars of its own funds in new facilities.

Astronaut White Walking in Space

The McDonnell Space Center

In 1957, the Company completed a multi-building Engineering campus and began construction of engineering, manufacturing, and laboratory installations now integrated into the McDonnell Space Center. Low speed polysonic, and hypersonic wind tunnels enable extensive aerodynamic testing of advanced aircraft and spacecraft designs. The low speed tunnel provides air flow testing up to 240 mph. The polysonic tunnel permits evaluation of designs at speeds from 0.5 to 5.8 times the speed of sound. The hypervelocity impulse tunnel, created by McDonnell to study conditions during missile flight and spacecraft reentry into the Earth's atmosphere, simulates speeds over 27 times the speed of sound and altitudes up to 60 miles.

Laboratories containing the latest technological equipment provide for structural testing, materials studies, systems evaluations, chemical analyses, propulsion studies, electronic investigations, and the development of advanced fabrication and assembly methods. Included in these laboratories are 14 space simulation chambers, two of which are man-rated and large enough to contain a complete spacecraft. These enable engineers to study the temperatures and pressures expected at orbital and reentry altitudes and speeds.

In McDonnell's manufacturing facilities, giant presses shape structural components with forces up to 10,000 tons. More than half a hundred

Hypervelocity Tunnel

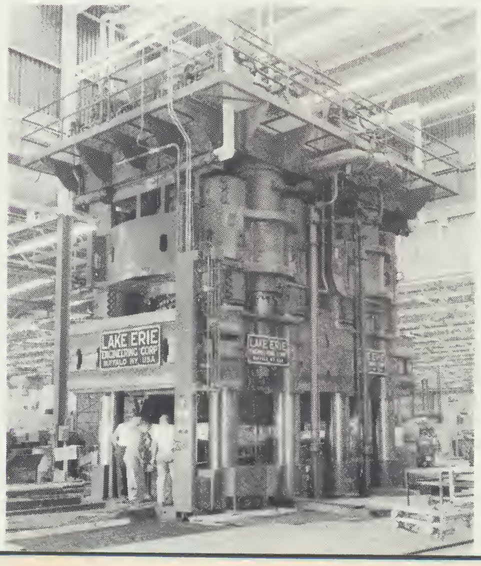
adaptive and numerically controlled machines automatically cut intricate units for complex parts. Chemical baths etch away unwanted weight. Hundreds of automatic drills, mills, lathes, punches, and profilers, welders, riveters, bonding machines, and furnaces form raw materials into structures for aircraft and spacecraft. Once tested and proven, these flow toward final assembly areas where experienced production personnel guide each piece and component into place. Aircraft take shape in vast high bay areas, and spacecraft are assembled in climate controlled clean rooms which protect sensitive components from contamination.

TOWARD DIVERSIFICATION

These modern administrative, engineering, research, and production facilities have helped make McDonnell a leader in the aerospace industry and one of the top 100 industries in the nation. To reach and maintain this position, in 1960 McDonnell began to diversify its interests and develop its capabilities in automation and electronics.

AUTOMATION

McDonnell has been a leader in the use of data processing and computing equipment since 1941, only two years after the firm was founded. The effective utilization of sophisticated systems design and programming techniques, as well as the latest hardware, have been significant



10,000 Ton Press

in the Company's growth. In October 1955, McDonnell made the largest single purchase of analog computing equipment any company had made to that date.

As aircraft systems grew more complex, McDonnell extended its use of computers for engineering problems. Electronic data handling absorbed payroll, inventory, quality control, and other digital loads. Scientific computers were used to simulate and analyze the dynamic pulse of aircraft and spacecraft taking shape on designers' drawing boards. The Phantom II was designed with the aid of computers and actually "test flown" on computers before production ever began. High speed numerical control machines, simulation techniques, and automatic data evaluation systems played a major role in the development and production of Mercury and Gemini spacecraft.

MCDONNELL AUTOMATION CENTER

On 21 March 1960, this capability for solving data handling and computing problems was organized into a separate Division as the McDonnell Automation Center. This was a diversification step that was to make a history of its own in a brief span. In addition to handling all of the Company's work, the Automation Center offered consultation, systems design, programming, computing, and data processing services to business, science, and industry throughout the nation.

As its work load increased, the Automation Center began to extend its capabilities with machines as well as people. In September 1961, it installed an IBM 7090 and a giant IBM 7080 data processing system, the first of its kind to be put into industrial use. In February 1963, the 7090 was replaced with an IBM 7094 scientific computer, the first installation of this equipment in the Midwest.

On 31 July 1963, Automation Center activities were expanded geographically with the acquisition of the Denver Electronic Computing Service, Inc., of Denver, Colorado. Known as DELCOS, this wholly-owned subsidiary provides a complete range of data processing services to banks, school districts, utilities, manufacturers, retailers, government agencies, and others in the Rocky Mountain region.

Two more steps in a planned expansion of Automation Center activities took place the following year. On 1 April 1964, the McDonnell Automation Center, Inc. was established in Columbia, Missouri, to function as a key

A Typical Data Processing Area

punching facility for all Automation Center operations. On 1 August 1964, MACTEX, the McDonnell Automation Center of Texas, Inc., was opened in Houston, Texas. The largest organization of its kind in the Gulf States, MACTEX provides a complete range of management and data processing services, including specialized areas of linear programming, stress analysis, pipeline flexibility analysis, and critical path scheduling, for the industrial Southwest. MACTEX particularly emphasizes McDonnell's ability to apply aerospace technology to other industries with its new applications in the petroleum and petrochemical industries.

The Automation Center's many accomplishments include the calculation of the optimum number and size of classrooms, lecture halls, and laboratories needed for a metropolitan Junior College District before the architect's final plans were drawn, the implementation of a comprehensive manufacturing control system for the metal fabrication industry, the development of a scientific system to optimize a schedule of engine testing for a farm equipment manufacturer, and the reduction of biomedical data for a university.

The McDonnell Automation Center services over a dozen banks and schedules more than

7080 Data Processing System

100,000 students in the St. Louis area alone. It has processed grade reporting and student scheduling applications for schools in Colorado, Illinois, Indiana, Massachusetts, Minnesota, Missouri, Pennsylvania, and Texas.

Each year since its founding, the McDonnell Automation Center has continued to expand its client list and services. This has permitted the installation of additional electronic data processing and computing equipment and the addition of specially skilled people. In June 1965, the Automation Center began a new equipment program with the installation of an IBM System 360 Model 30 computer, the first of its kind to go into commercial operation. The System 360 series of computers incorporate microelectronic circuits and operate at speeds measured in billionths of a second. When completed by the end of 1967, this replacement program will more than double the Automation Centers' computing capabilities.

By the spring of 1966, McDonnell Automation Centers in St. Louis, Denver, Houston, and Columbia were operating over $25 million worth of equipment ranging from punched card processors and small calculators to large digital and analog computers. They employ almost 1000 specialized personnel.

360 Data Processing System

ELECTRONICS

Since the end of World War II, the growth of the aerospace industry has been closely linked to rapid developments in electronics. During these years, McDonnell not only applied electronic equipment produced by other companies but developed its own specialized products to support company aerospace programs. McDonnell electronic developments have included research in microcircuitry and other techniques for the electronic equipment of the future, Project Mercury and Gemini pilot procedural trainers and simulators, the Gemini time reference system, and flight control systems and automatic checkout equipment for aircraft and spacecraft. McDonnell also designed an aircraft collision avoidance system which provides position, altitude, and identification information to ground operators as well as positive cockpit instructions for collision avoidance. The system uses a unique synchronization technique which permits almost continuous analysis of range and range rate.

ELECTRONIC EQUIPMENT DIVISION

As a continuation of its diversification program, on 9 January 1961 McDonnell organized these electronics capabilities into a separate Electronic Equipment Division. An amalgamation

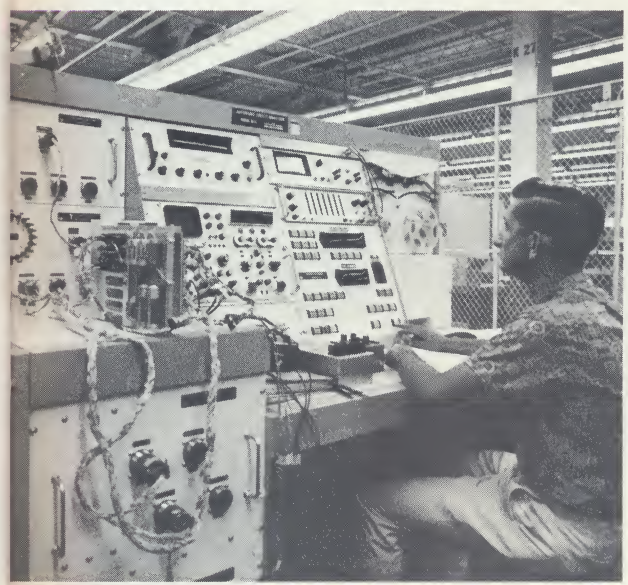
Electronics Operations

of several separate electronic groups within the Company, this new Division was established to design, develop, and manufacture specialized electronic products for government and industrial use as well as to provide support for other McDonnell activities.

During the next few years, this new Division grew rapidly. Beginning with 192 people, by June 1963 it employed 1300 and needed larger quarters. This necessitated a move into its own administrative, engineering, and manufacturing facilities. On 1 November 1963, the Company leased the Sterling Aluminum Company property in St. Charles, Missouri, and began moving its manufacturing operations into this 245,000 gross square foot facility.

On 6 February 1964, McDonnell acquired 21% of the common stock of Conductron Corporation, an Ann Arbor, Michigan firm founded in 1960 by Dr. Keeve M. Siegel, a University of Michigan Scientist, active in the development of very advanced electronic and mechanical systems.

On 15 April 1964, McDonnell purchased the Frederick P. Warrick Company of Clarkston, Michigan, a camera engineering firm organized in 1951, which had developed high speed cameras for use in missile tracking and space-



Electronics Operations

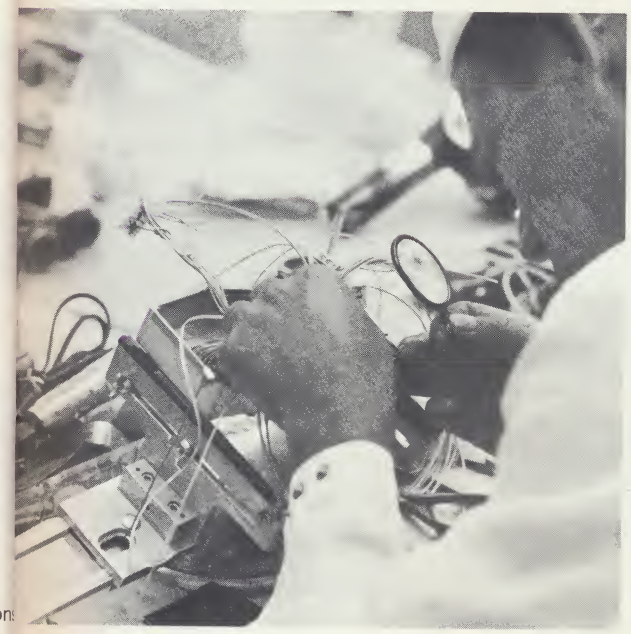
craft launchings. Warrick operations and personnel were moved to St. Louis and absorbed into the Electronic Equipment Division as a Camera Department responsible for specialized camera products.

On 24 April 1964, McDonnell bought 55% of the common stock of Hycon Manufacturing Company of Monrovia, California, a producer of airborne reconnaissance camera systems. On 1 August 1964, McDonnell further expanded its electronics capabilities by purchasing the assets of Tridea Electronics Company of South Pasadena, California, an engineering oriented electronics firm organized in the spring of 1959, which specializes in the field of radar and radar systems. Included among Tridea's products are specialized ground support equipment, low frequency beacons, and a digital moving target indicator system which can be used with existing ground based or airborne radars to eliminate ground clutter for the detection of low flying aircraft. With the purchase of Tridea, McDonnell also acquired 48% of the common stock of Advanced Communications, Inc., of Chatsworth, California, which specializes in the research, design, and development of electronic communications systems and equipment.

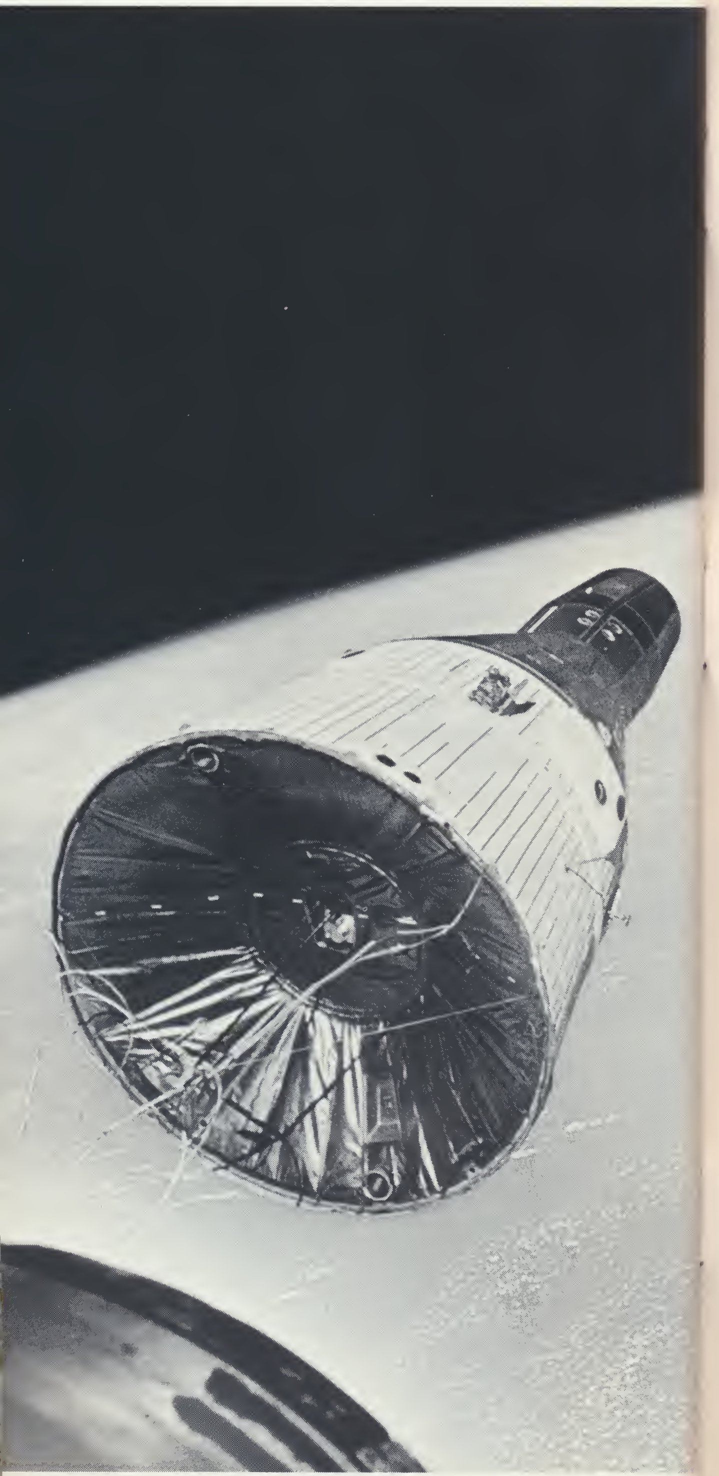
Electronics Operations

In September 1965, the Electronic Equipment Division's simulation experience earned orders for the 737 airline transport crew training simulators, the Division's first major non-government sale. Ordered by Boeing Company and United Air Lines, with other orders pending, the 737 flight crew training simulator recreates sound, motion, sight, touch, and "out the window" coordination with 99.3% reliability.

On 5 November 1965, McDonnell announced that it would shortly transfer its Electronic Equipment Division and Tridea to Conductron Corporation in exchange for Conductron stock. This arrangement was completed on 25 January 1966, and McDonnell acquired 80% of Conductron's stock. The St. Louis Division, known as Conductron-Missouri, occupies on a lease basis property in St. Charles which McDonnell purchased on 5 January 1966. This merger of McDonnell's electronic design and production experience and facilities with Tridea and Conductron's scientific and research capabilities constituted a major move in McDonnell's planned diversification into civil and commercial product development.



Electronics Operations



PERSPECTIVE

McDonnell, as the designer and producer of the Free World's fastest and most powerful fighter aircraft, and as the builder of the Free World's first manned orbital spacecraft, has made major contributions to man's understanding of the universe in which we live.

Astronaut John Glenn, visiting McDonnell after America's first manned orbital flight, told employees, "You have become complete professionals in the space field where, just a few years ago, there wasn't any profession . . . it took a lot of you whom I am looking at here today, to put the actual hardware together, and I know the way it was put together and the way the mission worked out. It was more than just a wage you were getting paid . . . your hearts went into it."

Astronaut John Glenn, Walter F. Burke, Vice President and General Manager Spacecraft and Missiles, and Mr. McDonnell.

Gemini VII photographed from Gemini VI during the world's first rendezvous of two manned orbiting spacecraft.

President Kennedy and Mr. McDonnell

David S. Lewis, President of McDonnell, James E. Webb, NASA Administrator, President Kennedy, James S. McDonnell, Chairman of the Board and Chief Executive Officer, and Sanford N. McDonnell, Vice President and General Manager Aircraft, observing Phantom II Assembly Operations.

In an unprecedented industrial visit on 12 September 1962, President John F. Kennedy spoke to McDonnell employees about their contribution to the nation with the Mercury and Gemini Spacecraft. He said, "I can imagine no action . . . which is more essential and exciting than to be involved in the most important and significant adventure that any man has been able to participate in in the history of the world . . . ."

This is the perspective at McDonnell today, building products for defense to protect the peace and products for space to stimulate the restless, creative souls of mankind, a Company challenging the frontiers of progress in aeronautics, astronautics, electronics, and automation.